

**Performance Audit  
City Should Document GIS Data**

November 2010

**City Auditor's Office**

**City of Kansas City, Missouri**



## Office of the City Auditor

21st Floor, City Hall  
414 East 12th Street  
Kansas City, Missouri 64106

(816) 513-3300  
Fax: (816) 513-3305

November 3, 2010

Honorable Mayor and Members of the City Council:

This performance audit of the city's geographic information system (GIS) was initiated by the city auditor pursuant to Article II, Section 216 of the city charter. The audit focuses on documentation of the city's GIS data maintained in the Information Technology Department's (ITD's) centralized database.

The Information Technology Department does not require city staff who develop and maintain GIS data layers in the city's centralized database to document this data. As a result, the only documentation about the data is the limited information that the software automatically generates. GIS data layers are made up of spatial data that city departments use to create maps and analyze data. Documentation about GIS layers could include important characteristics of the data such as the purpose of the data, creation date, who created the data, data limitations, contact information, and legal requirements.

Without written documentation about the data layer, when staff retire or change jobs, important information about the data is lost, which may result in the need to recreate the dataset. The city will waste money spent to create the data if staff do not properly document the data. We estimate the city will spend at least \$2.4 million in salaries and benefits over the next five years for ITD staff to create and maintain this data. Besides the risk of wasting the money spent on GIS, lack of documentation could result in city decision-makers basing decisions on inappropriate data. GIS data users may also be less efficient due to lack of data documentation. Users may have to test data for completeness or contact the data developer with questions that documentation could easily answer.

Documentation of the GIS data layers would preserve the data's history and allow the data user to assess the layer's quality, completeness, and relevance. The audit includes a recommendation intended to protect the city's investment in GIS data and improve staff efficiency by improving documentation of GIS data layers.

We shared a draft of this report with the city's chief information officer on October 12, 2010. His response is appended. We would like to thank the Information Technology Department for its assistance and cooperation. The audit team for this project was Renata Matos and Sue Polys.

Gary L. White  
City Auditor

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# City Should Document GIS Data

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## Introduction

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### Objectives

We conducted this audit of geographic information system (GIS) data documentation under the authority of Article II, Section 216 of the Charter of Kansas City, Missouri, which establishes the Office of the City Auditor and outlines the city auditor's primary duties.

Documentation of GIS data protects the city's investment in GIS. It also improves the efficiency of producing GIS products such as maps. We focused on the documentation of layers, which are the datasets used to create maps. The Information Technology Department (ITD) maintains a centralized GIS database that contains layers of data used by ITD and other city departments.

A performance audit provides assurance or conclusions based on an evaluation of sufficient, appropriate evidence against stated criteria. Performance audits provide objective analysis so that management and those charged with governance and oversight can use the information to improve program performance and operations, reduce costs, facilitate decision-making, and contribute to public accountability.<sup>1</sup>

This report is designed to answer the following question:

- Does the city document geographic information system data layers?

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### Scope and Methodology

Our review focuses on documentation of data maintained in ITD's GIS database. Our audit methods included:

- Reviewing procedure manuals to identify ITD's GIS group's expected practices for documenting GIS datasets.

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<sup>1</sup> Comptroller General of the United States, *Government Auditing Standards* (Washington, DC: U.S. Government Printing Office, 2007), p. 17.

- Interviewing city ITD staff to determine actual practices for documenting GIS datasets.
- Reviewing GIS data documentation standards and literature and interviewing GIS users in other departments to identify benefits of GIS data documentation.
- Reviewing all layer datasets in the GIS database to determine whether they had documentation.

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective.

We communicated an internal control weakness unrelated to the audit objective to the chief information officer in a separate memorandum. No information was omitted from this report because it was deemed privileged or confidential.

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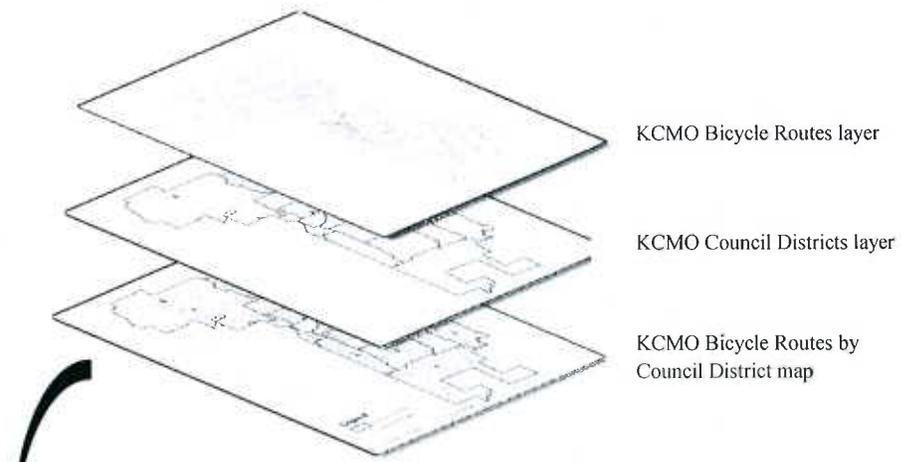
## **Background**

### **Geographic Information System**

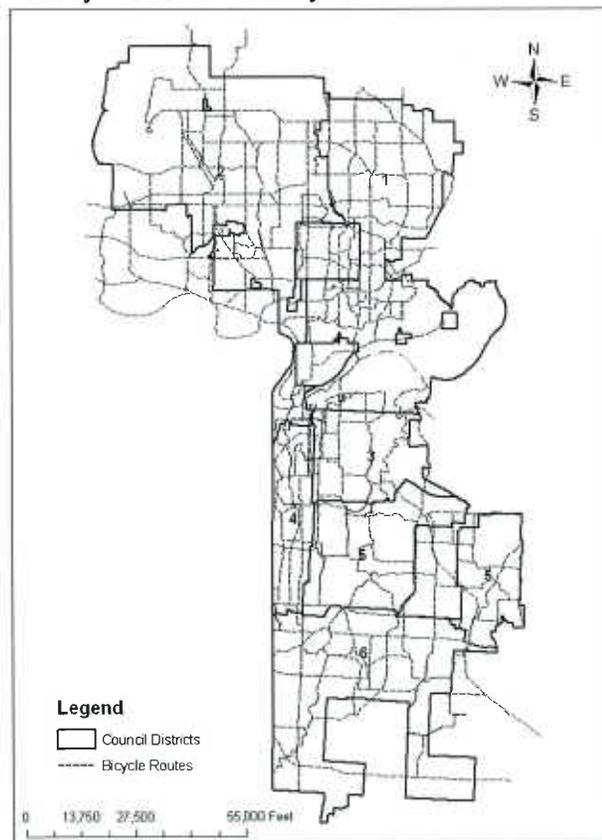
A geographic information system (GIS) integrates hardware, software, and data for managing, analyzing, and displaying all forms of geographically referenced information.

In GIS, the files used to create maps are called layers. A layer is a set of spatial data that are represented by points (e.g. cities in Missouri), lines (e.g. majors streets), or areas (e.g. states). Each layer usually has one theme. For example, a layer may represent bicycle routes in Kansas City, Missouri, and another layer may represent the council districts. To have the information about bicycle routes in Kansas City by council district you add the two layers in a map. (See Exhibit 1.)

Exhibit 1. Layers of a Map



### Bicycle Routes By Council Districts



Source: Information Technology Department GIS database.

Documentation of GIS data refers to information describing the data layers. The documentation should summarize the basic characteristics of the data including content, quality, type, and spatial information about a layer. It represents the who, what, when, where, why, and how of the layer. Documentation of GIS data helps users find (e.g. with this documentation, the layers become searchable by keywords), interpret, and use the data. Appendix A provides an example of documentation of GIS data created by the City of Bellingham, Washington.

### **The City's Geographic Information System**

The city's GIS data is located in a centralized GIS database that ITD manages. According to ITD, its staff and Water Department staff are the only ones who post and edit layers in the GIS database. Staff in other departments has access to view and use the layers to build their maps, but are not able to edit the data.

Departments use GIS to create maps and analyze data. For example, the City Planning and Development Department uses GIS to analyze market absorption trends and demographics, forecast infrastructure needs, and create maps for presentations and planning. The Finance Department uses GIS to see where tax incentive money is spent and break down sales tax information into city districts or zip codes.

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## Findings and Recommendations

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### Summary

City staff who create and maintain geographic information system (GIS) data layers in the city's centralized database do not document this data, other than the documentation that the software automatically generates. Without written documentation about the layer, when staff retire or change jobs, important information about the data is lost, which may result in the need to recreate the dataset. Lack of documentation could also result in decision-makers basing decisions on inappropriate data. Written documentation about the GIS layers reduces the data user's need to perform tests on the data to establish its completeness or to find who created the data and ask questions. In order to protect the city's investment in the geographic information system (GIS) data, avoid inappropriate use of data, and improve the efficiency of data users, the city should require documentation for data layers published on the city's GIS database.

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### GIS Documentation Needed to Protect the City's GIS Investment

City staff do not document geographic information system (GIS) layers as they create and maintain this data. The city does not have a policy requiring GIS layer documentation. Documentation about GIS layers could include important characteristics of the data such as the purpose of the data, creation date, who created the data, data limitations, contact information, and legal requirements. Lack of documentation jeopardizes the city's investment in GIS data, increases the risk of using inappropriate data for decision-making, and creates inefficiencies for data users.

#### **City's GIS Data Lacks Adequate Documentation**

The Information Technology Department (ITD) does not have a policy requiring documentation in order to post layers in the GIS database. City staff do not document information about GIS layers other than limited data that the software automatically generates.

**ITD policies do not require GIS data documentation.** ITD does not have policies or procedures requiring ITD staff or staff in other departments to document GIS layers before posting the data to the

centralized database. Although the city's GIS software, ArcGIS, automatically documents some information about GIS layers, city staff, including ITD GIS staff, do not include any other documentation about the data in the GIS software. Of the city's approximately 230 GIS layer datasets, about 65 percent had no documentation explaining the data. The other 35 percent of the datasets only had the limited documentation that ArcGIS automatically generates. Some of the auto-generated documentation includes the location of the file, the horizontal and vertical coordinate system, bounding coordinates, and point and vector object information. Without complete documentation, it is difficult to determine a layer's quality and relevance.

The federal government is required to follow documentation standards for GIS datasets. The Federal Geographic Data Committee (FGDC)<sup>2</sup> developed the federal GIS documentation standard.<sup>3</sup> Some local and state governments have also adopted the standard. The objective of FGDC's standard is to provide a common set of terminology and definitions for the documentation of GIS data. The common language, which the standard provides, allows GIS developers and users, both within and outside the organization, to identify what datasets are available and to determine their relevance.

An ITD policy requiring documentation of GIS data before the data can be loaded to the database would help ensure that city staff is consistently documenting the layers. The department's use of a documentation standard like FGDC would help ensure that relevant and consistent information about the data is documented.

Documentation of GIS layers could include:

- Summary of what the dataset represents;
- Description of the dataset, including its intended use and limitations;
- Assessment of quality of the dataset;
- Information about omissions, selection criteria, definitions used, and other rules used to derive the dataset;
- Time period for which the data is relevant;
- Keywords;

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<sup>2</sup> The Federal Geographic Data Committee is an interagency committee that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. The federal Office of Management and Budget established the FGDC in 1990.

<sup>3</sup> FGDC's documentation standard is called the Content Standard for Digital Geospatial Metadata. FGDC is currently working on revising its standard to incorporate the International Organization of Standards' data documentation standards.

- Who created the dataset and when it was created;
- Contact information for the dataset;
- Whether the data is completed or in progress; and
- Restrictions and legal prerequisites for using the dataset.

**Documenting GIS data is beneficial to those that develop the data layer and those that use it.** GIS documentation is a key component of the geospatial dataset. Its benefits include:

- Preserving the value of GIS data, which is an expensive component of GIS, by having staff document data history as they create it. When staff retire or change jobs, important information about the dataset is not lost.
- Providing the data user with the information needed to locate, evaluate, and assess GIS data with the result that the data developer has less data inquiries to answer.
- Providing the organization with a searchable in-house catalog of the organization's data. The catalog can be searched to determine whether needed data already exists or can be adapted for a needed purpose.
- Declaring data limitations. It is an opportunity to state what the data are not and is useful in determining the appropriate application of the data.
- Enabling organizations to retrieve in-house data resources by specific criteria and perform maintenance through global edits and annual updates.
- Allowing the public to search available GIS data resources via the Internet.
- Enabling software systems to properly read the data.
- Establishing data accountability by requiring the data developer to be associated with the data.

### **City's \$2.4 Million Future Expenditure in GIS Is at Risk without Proper Documentation**

We estimate that the city will spend at least \$2.4 million on GIS in the next 5 years. If staff have to recreate existing GIS layers because of the lack of documentation, some of the time and money spent to create the existing layers of data is wasted. Besides the risk of losing the money invested in GIS staffs' time, lack of documentation could lead to

decisions by city leadership based on inappropriate data, misrepresentation of data to the public, and inefficient use of staff time.

**GIS data documentation will protect ITD's time investment.** The city may lose its investment in GIS data layers if there is turnover of GIS analysts or data developers and they leave without having documented their work. We estimate that over the next five year, the city will spend \$2.4 million<sup>4</sup> in salaries and benefits for the six ITD GIS employees that create and maintain the GIS datasets. Without documentation, employees taking over datasets from staff that have left may have to recreate or verify existing data layers because they would not know important characteristics about the data including the data layer's purpose, when former staff last updated it, what the data limitations are, or how complete the data is. If staff have to redo existing layers due to a lack of data history, some of the time and money spent originally to create the layers is wasted. When an ITD employee assigned to GIS, took over about 10 GIS data layers from a staff person who left the department, there was little documentation on the datasets. The staff member reported spending approximately one third of a year verifying and updating the newly assigned datasets.

**Lack of documentation of GIS data could lead to inappropriate use of data and inefficiencies for data users.** Without documentation, GIS users may rely on data that is not relevant, resulting in city leadership making decisions based on inaccurate information or dissemination of inaccurate information to the public. In addition, without knowing the purpose of the data, its limitations, and how the developer defined the data, a user may misunderstand or misrepresent the dataset. For example, assume the city was preparing a grant application for public transit money and had to provide the grantor with existing mass transit routes in the metropolitan area. The preparer selects a metropolitan map assuming that it includes Southern Johnson County but it turns out it did not. In that case, the grant application would not include all area's actual transit routes. Had the dataset been adequately documented, the person preparing the grant would have known not to use that dataset because it did not contain all the transit routes.

Without GIS documentation, dataset users may also spend unnecessary time trying to determine whether the dataset is complete and relevant for the intended use. Staff from two departments said that before they use the city's GIS layers, they do their own comparisons of GIS datasets to other sources of data they have access to in order to establish the data's

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<sup>4</sup> This projection is for FY 2011 to FY 2015 and is based on FY 2011 salaries and benefits for GIS staff. This calculation assumes salaries do not change.

completeness. Data users have to spend time contacting the data developer to ask questions about the data if developers do not document it. One of the staff said he keeps information he has gathered about some data layers next to his computer. He gathered the information by calling ITD at various times. The data user should not have to call when they have basic questions about the layers. If staff creating and maintaining GIS layers document the important information about the dataset, the data user's efficiency should increase. Creating GIS layer documentation when the dataset is developed and then regularly updating the documentation with changes to the data will save the city time and money later.

To protect the city's investment in GIS data, ensure that the city's datasets are consistently documented, and improve efficiency of data users, the chief information officer should require GIS data documentation that follows the FGDC standard or its equivalent, for datasets published on ITD's GIS database.

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## **Recommendation**

1. The chief information officer should require GIS data documentation that follows the Federal Geographic Data Committee standard (or its equivalent) for datasets published on ITD's GIS database.

*City Should Document GIS Data*

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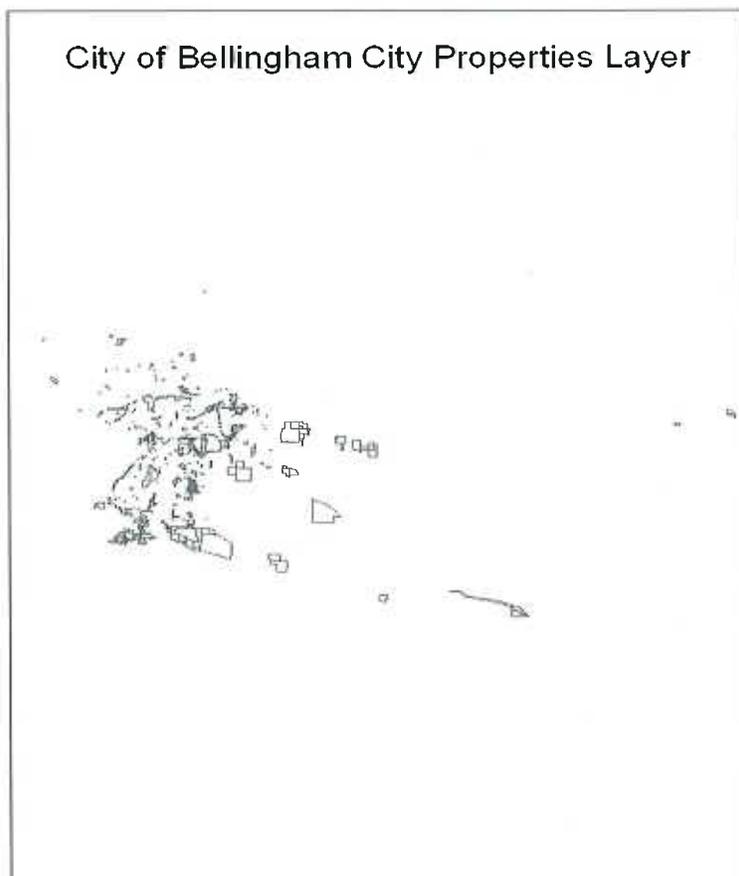
## **Appendix A**

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### **GIS Data Documentation Example - City of Bellingham, Washington**



Below is an example of a GIS data layer displayed as a map and its accompanying documentation. We downloaded a copy of a GIS map<sup>5</sup> and its documentation<sup>6</sup> from the city of Bellingham, WA. The map illustrates a GIS data layer of properties owned by Bellingham. The city's documentation describing the data layer follows the map.



5 Downloaded from [http://www.cob.org/documents/gis/maps/cityprop\\_dept.jpg](http://www.cob.org/documents/gis/maps/cityprop_dept.jpg) on 8/12/2010.

6 Downloaded from [http://www.cob.org/services/maps/GIS\\_data/CityProperty.xml](http://www.cob.org/services/maps/GIS_data/CityProperty.xml) on 6/24/2010.



## City of Bellingham City Properties Metadata

Show Definitions

Description | Spatial | Data Structure | Data Quality | Data Source | Data Distribution | Metadata

### + Description

#### Citation

**Title:** City of Bellingham City Properties

**Originators:** City of Bellingham

**Publisher:** City of Bellingham, Public Works Department

**Publication place:** Bellingham, WA

**Publication date:** 20090116

**Data type:** vector digital data

**Data location:** <http://www.cob.org/services/maps/index.aspx>, <http://www.cob.org>

#### Description

**Abstract:** City Property is a polygon featureclass which contains properties owned by the City of Bellingham. Attributes include which department owns it, what fund paid for it, and other descriptive information.

**Purpose:** The purpose of the city property data is to show the location of City owned properties within Whatcom County

#### Point Of Contact

**Organization:** City of Bellingham

**Person:** Public Works GIS Staff

**Position:** Public Works GIS Staff

**Phone:** 360-778-7700

**Fax:** 360-778-7701

**Email:** [gishelp@cob.org](mailto:gishelp@cob.org)

**Instructions:** <http://www.cob.org/services/maps/index.aspx>

**Address type:** mailing and physical address

**Address:** 2221 Pacific St

**City:** Bellingham

**State or Province:** WA

**Postal code:** 98229

#### Data Type

**Data type:** vector digital data

**Native dataset environment:** Microsoft Windows XP Version 5.1 (Build 2600) Service Pack 2; ESRI ArcCatalog 9.2.2.1350

<p><b>Time Period of Data</b></p> <p><i>Date:</i> 20090224  <i>Currentness reference:</i> Publication date</p>
<p><b>Status</b></p> <p><i>Data status:</i> Complete  <i>Update frequency:</i> As needed</p>
<p><b>Key Words</b></p> <p><i>Theme:</i>  <i>Keywords:</i> planning Cadastre, structure  <i>Keyword thesaurus:</i> ISÖ 19115 Topic Category</p> <p><i>Theme:</i>  <i>Keywords:</i> Cadastral, Facilities  <i>Keyword thesaurus:</i> COB</p> <p><i>Place:</i>  <i>Keywords:</i> City of Bellingham, United States, Washington, Whatcom County  <i>Keyword thesaurus:</i> None</p>
<p><b>Data Access Constraints</b></p> <p><i>Access constraints:</i> None.  <i>Use constraints:</i> None. Data are considered current to the date of the original source material. Please check sources, scale, accuracy, currentness and other available information. Please confirm that you are using the most recent copy of both data and metadata.</p>
<p><b>Data Security Information</b></p> <p><i>Security classification system:</i> COB Metadata Implementation  <i>Security classification:</i> No Confidentiality  <i>Security handling:</i> Standard Technical Controls</p>
<p>+ Spatial Reference Information</p>
<p><b>Horizontal Coordinate System</b></p> <p><i>Coordinate System Details</i></p> <p><i>Map projection</i></p> <p><i>Map projection name:</i> Lambert Conformal Conic  <i>Standard parallel:</i> 47.500000  <i>Standard parallel:</i> 48.733333  <i>Longitude of central meridian:</i> -120.833333</p>

**Latitude of projection origin:** 47.000000  
**False easting:** 1640416.666667  
**False northing:** 0.000000

**Planar Coordinate Information**

**Planar coordinate encoding method:** coordinate pair

**Coordinate representation:**

**Abscissa resolution:** 0.000195

**Ordinate resolution:** 0.000195

**Planar distance units:** survey feet

**Geodetic model**

**Horizontal datum name:** North American Datum of 1983

**Ellipsoid name:** Geodetic Reference System 80

**Semi-major axis:** 6378137.000000

**Denominator of flattening ratio:** 298.257222

**Spatial Domain**

**Bounding Coordinates**

**In Unprojected coordinates (geographic)**

Boundary	Coordinate
West	-122.574 (latitude)
East	-122.303 (latitude)
North	48.623 (longitude)
South	48.644 (longitude)

**+ Data Structure and Attribute Information**

**Overview**

**Entity and attribute overview:** City Property attributes include descriptive information, parcel ID, department and fund responsible for the property, acquisition dates and costs, and LA Code. LA Code is an internal tracking number.

**Entity and attribute detailed citation:** COB

**+ Data Quality and Accuracy Information**

**General**

**Logical consistency report:** Tests for integrity have not been performed.

**Completeness report:** Features represented have not been tested for completeness

**Positional Accuracy**

**Horizontal accuracy report:** Horizontal positional accuracy may vary greatly throughout

these data. Consult attribute descriptions to locate a horizontal accuracy code if present.

+ Data Source and Process Information

**Process Steps**

**Process step information**

**Process Step 1**

**Process description:** Metadata created.

**Process date:** 20090216

+ Data Distribution Information

**General**

**Resource description:** Offline Data

**Distribution liability:** The City of Bellingham has developed these data and maps for its own use and no warranty expressed or implied is made regarding the merchantability and fitness for a particular purpose nor shall the act of distribution constitute any such warranty. It is also strongly recommended that careful attention be paid to the contents of the metadata file associated with these data to evaluate data set limitations, restrictions, or intended use. The City of Bellingham shall not be held liable for improper or incorrect use of the data described and/or contained herein. The risk or liability resulting from the use of this product is entirely assumed by the user.

**Distribution Point of Contact**

**Organization:** City of Bellingham

**Person:** Public Works GIS Staff

**Position:** Public Works GIS Staff

**Phone:** 360-778-7700

**Fax:** 360-778-7701

**Email:** gishelp@cob.org

**Instructions:** <http://www.cob.org/services/maps/index.aspx>

**Address type:** mailing and physical address

**Address:** 2221 Pacific St

**City:** Bellingham

**State or Province:** WA

**Postal code:** 98229

+ Metadata Reference

**Metadata Date**

**Last updated:** 20090224

**Future metadata review date:** 20110224

#### Metadata Point of Contact

**Organization:** City of Bellingham  
**Person:** Public Works GIS Staff  
**Position:** Public Works GIS Staff  
**Phone:** 360-778-7700  
**Fax:** 360-778-7701  
**Email:** gishelp@cob.org  
**Instructions:** <http://www.cob.org/services/maps/index.aspx>  
**Address type:** mailing and physical address  
**Address:** 2221 Pacific St  
**City:** Bellingham  
**State or Province:** WA  
**Postal code:** 98229

#### Metadata Standards

**Standard name:** FGDC Content Standard for Digital Geospatial Metadata  
**Standard version:** FGDC-STD-001-1998

#### FGDC Plus Metadata Stylesheet

**Stylesheet:** FGDC Plus Stylesheet  
**File name:** FGDC Plus.xsl  
**Version:** 2.0

**Description:** This metadata is displayed using the FGDC Plus Stylesheet, which is an XSL template that can be used with ArcGIS software to display metadata. It displays metadata elements defined in the Content Standard for Digital Geospatial Metadata (CSDGM) - aka FGDC Standard, the [ESRI Profile of CSDGM](#), the [Biological Data Profile of CSDGM](#), and the [Shoreline Data Profile of CSDGM](#). CSDGM is the US Federal Metadata standard. The [Federal Geographic Data Committee](#) originally adopted the CSDGM in 1994 and revised it in 1998. According to Executive Order 12096 all Federal agencies are ordered to use this standard to document geospatial data created as of January, 1995. The standard is often referred to as the FGDC Metadata Standard and has been implemented beyond the federal level with State and local governments adopting the metadata standard as well. The Biological Data Profile broadens the application of the CSDGM so that it is more easily applied to biological data that are not explicitly geographic (laboratory results, field notes, specimen collections, research reports) but can be associated with a geographic location. Includes taxonomical vocabulary. The Shoreline Data Profile addresses variability in the definition and mapping of shorelines by providing a standardized set of terms and data elements required to support metadata for shoreline and coastal data sets. The FGDC Plus Stylesheet includes the Dublin Core Metadata Element Set. It supports W3C DOM compatible browsers such as IE7, IE6, Netscape 7, and Mozilla Firefox. It is in the public domain and may be freely used, modified, and redistributed. It is provided "AS-IS" without warranty or technical support.

**Instructions:** On the top of the page, click on the title of the dataset to toggle opening and closing of all metadata content sections or click section links listed horizontally below the title to open individual sections. Click on a section name (e.g. Description) to open and close section content. Within a section, click on a item name (Status, Key Words, etc.) to open and close individual content items. By default, the Citation information within the Description section is always open for display.

**Download:** FGDC Plus Stylesheet is available from the ArcScripts downloads at [www.esri.com](http://www.esri.com).

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**Appendix B**

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**Chief Information Officer's Response**





## Interdepartmental Communication



**DATE:** October 27, 2010  
**TO:** Gary White, City Auditor  
**FROM:** Ivan Drinks, Chief Information Officer, Information Technology Department   
**SUBJECT:** GIS Data Documentation Audit—ITD Response

ITD agrees with the City Auditor recommendation and proposes the following plan to comply with the audit recommendation.

- ITD will develop a data documentation (metadata) policy and procedure that follows the *North American Profile of ISO 19115: Geographic Information – Metadata (NAP)*. The NAP is the new standard set to be processed by the Federal Geographic Data Committee for geospatial metadata.
- The developed metadata policy and implementation will include all required metadata elements in the NAP standard, any audit recommended elements that are not required by the standard, and data distribution procedures. At a minimum, the metadata will include the following audit recommended elements:
  - Summary of what the dataset represents
  - Description of the dataset, including its intended use and limitations
  - Assessment of quality of the dataset
  - Information about omissions, selection criteria, definitions used, other rules used to derive the dataset
  - Time period for which the dataset is relevant
  - Contact information for the dataset
  - Who created the dataset and when
  - Keywords
  - Whether the data set is complete or in progress
  - Restrictions and legal pre-requisites for using the dataset
- ITD will work with City departments to compile and document the metadata elements for current data sets.

- Require all new datasets to have the required metadata before publishing in the enterprise geodatabase.
- Incorporate metadata practices into our data maintenance SOP's. Develop metadata practices for documenting the geodatabase, mapping documents, and other ancillary information.

Unless instructed otherwise, ITD will take action on the above steps immediately. The final implementation (i.e. updating and storing the metadata within the enterprise GIS database) will take place after the enterprise system is upgraded to ArcGIS version 10, currently scheduled for March 2011.

Please do not hesitate to contact me at 513.0828 if you have any questions.

dh

Cc: Mary Miller, Deputy CIO  
Jennifer Hopkins, Assistant Director